

SYNCHRONIZING UNIT
KS5



USER'S MANUAL



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1 APPLICATION

The KS5 digital synchronizing unit has been designed for the synchronization of generators switched for parallel operation with the grid or with other generators with rated frequency of 50 or 60 Hz. Frequency differences, voltage values, and phase shifts are shown on a 3.5" color TFT display screen with a resolution of 320 x 240 pixels.

Bar graphs with zero in the middle marked δf and δU indicate respectively the difference in frequency and the difference in voltage values of the generator and network signals. Phase shift ϕ of the generator and network voltage signals is indicated by a circular synchronoscope. The spin speed corresponds to the difference between the network and the generator frequency.

The synchronization point, i.e. the moment when the frequency, voltage and phase values of the generator and the network are equal, is indicated by green indicators on the bar graphs and inside the circle. With proper control of the BLK and START signals (detailed in p.7.3), the SYNC synchronization relay will be activated.

The values of the measured quantities and deviations can be transferred to the master system via RS485 interface or Ethernet.

The synchronizing unit has a galvanic separation between the individual blocks of:

- power supply,
- voltage inputs,
- Input control signals,
- RS485 Interface,
- Ethernet Interface:
- relay outputs

2 METER SET

Complete set of the Analyzer includes:

- | | |
|---|--------|
| 1. KS5 synchronizing unit | 1 pc. |
| 2. gasket | 1 pc. |
| 3. mounting brackets to fix the device in the panel | 4 pcs. |
| 4. connector with 16 screw terminals | 1 pc. |
| 5. connector with 14 screw terminals | 1 pc. |



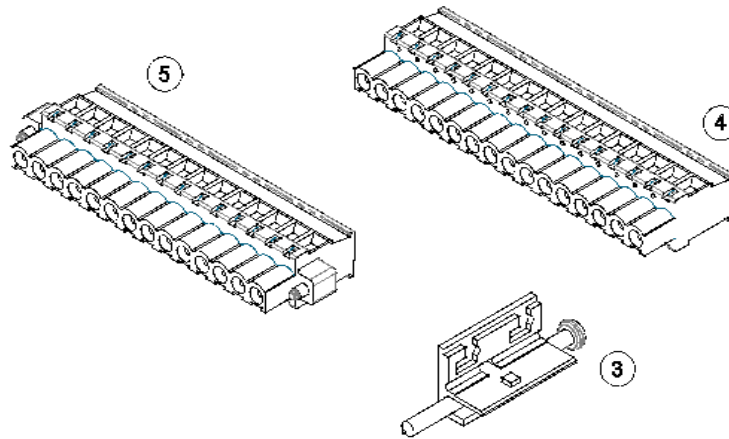


Fig.1, Meter set

3 BASIC REQUIREMENTS, OPERATIONAL SAFETY

In terms of operational safety the synchronizing unit meets the requirements of DIN EN 61010-1.



Safety instructions:

- The meter installation and connection should be made by qualified personnel. All available protection requirements must be taken into consideration.
- Prior to turning the meter on verify the connections.
- Prior to removing the meter housing, always turn the supply off and disconnect the measurement circuits.
- Removal of the meter housing during the warranty period voids the warranty.
- The synchronizing unit meets the requirements for electromagnetic compatibility in industrial environment.
- A switch or a circuit-breaker should be installed inside the building or facility. It should be located near the device, easily accessible to the operator, and suitably marked.

4 INSTALLATION

The synchronizing unit is adapted to be fixed to the panel by means of mounting brackets, according to fig. 1. The housing is made of self-extinguishing plastic.

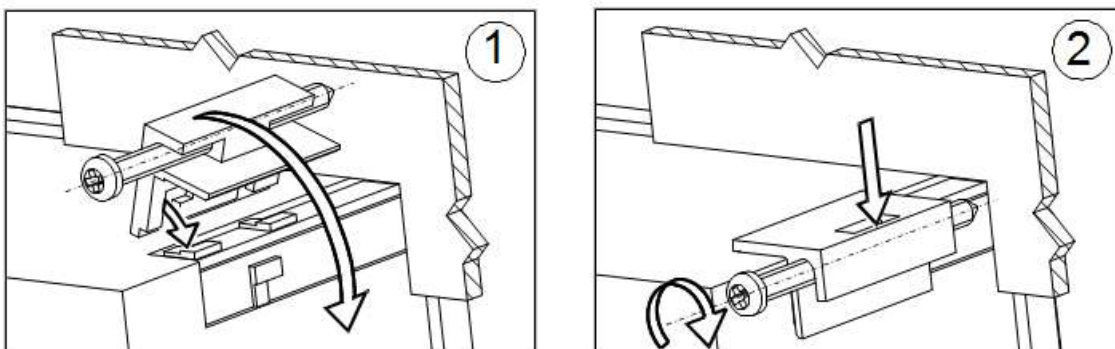


Fig.2. Meter fixing

Housing dimensions 96 x 96 x 77 mm, mounting hole dimensions 92.5 x 92.5 mm. Outside the meter there are screw terminals that allow connection of external wires with a cross-section up to 2.5 mm².

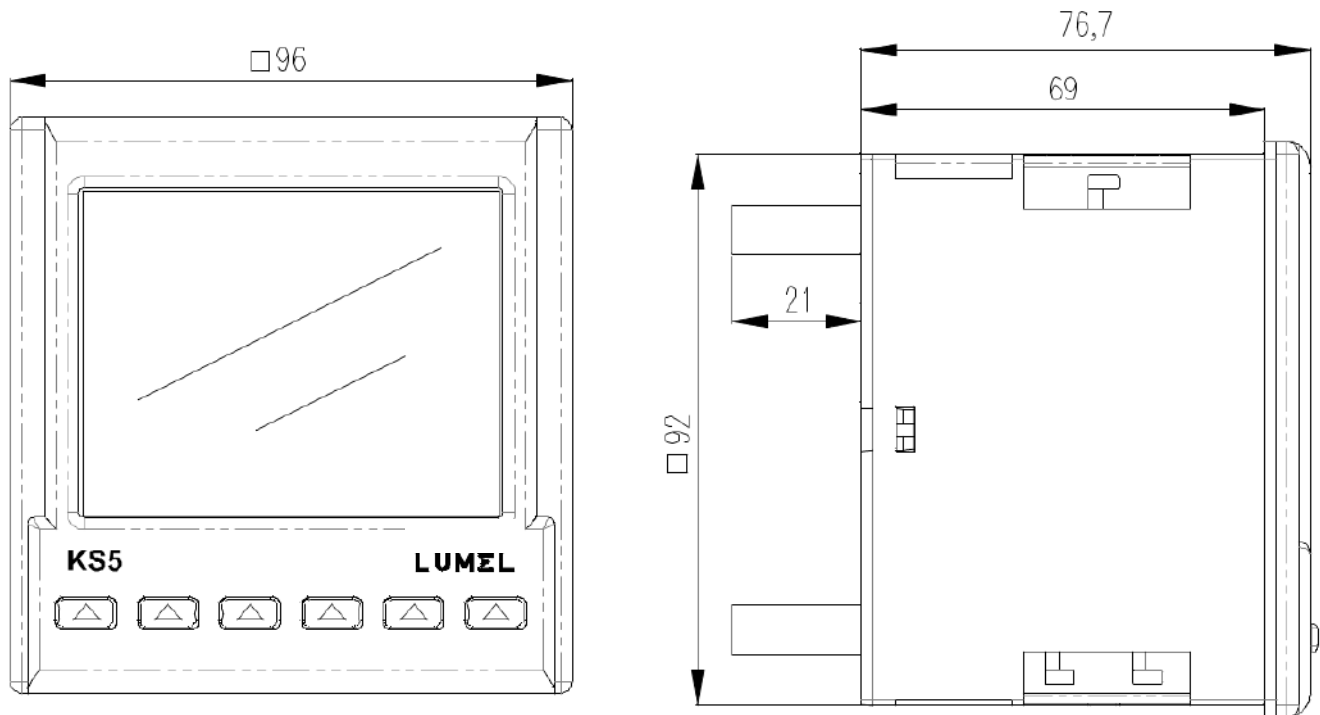


Fig.3. Overall dimensions of KS5 meter

5 DESCRIPTION OF THE INSTRUMENT

5.1 Voltage inputs

Voltage inputs are galvanically isolated (internal transformers). Un voltages (phase or phase-to-phase) are automatically recalculated by the input value of the external voltage transformer ratio. The voltage inputs specified in the order as 50...150 V or 150...400 V are programmable in the selected range. Maximum operating voltage relative to earth is 300 V.

5.2 External connections diagram

External connections are shown in Figures 4a, 4b.

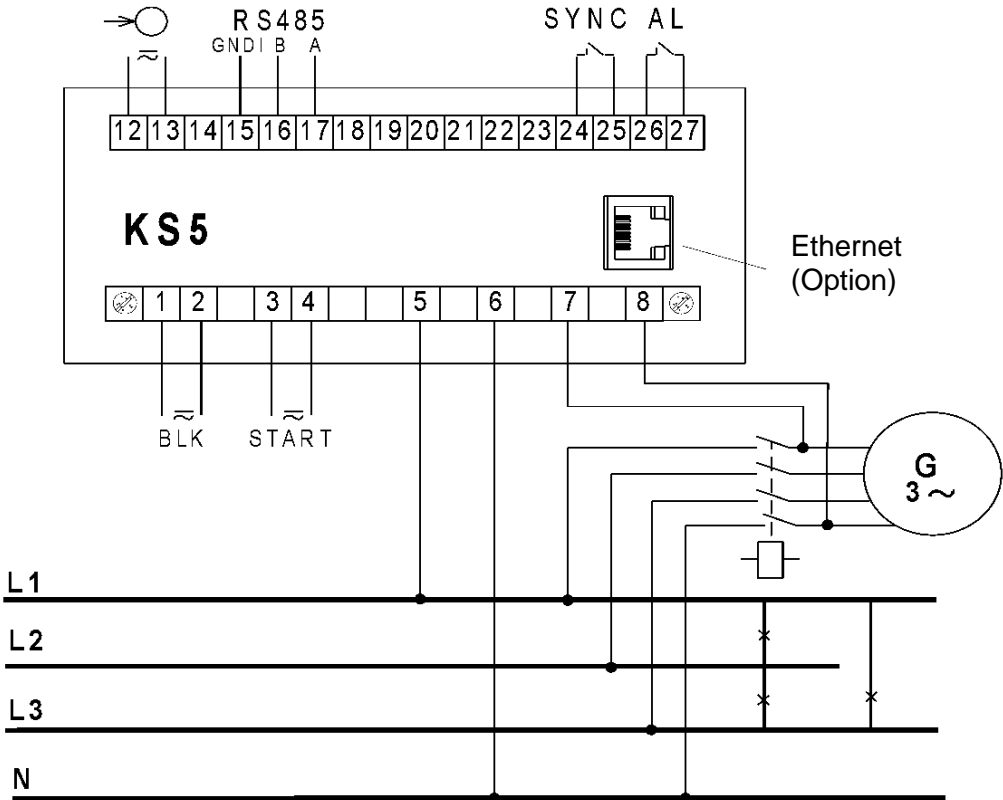


Fig. 4a. Connections of the synchronizing unit - phase measurement voltages

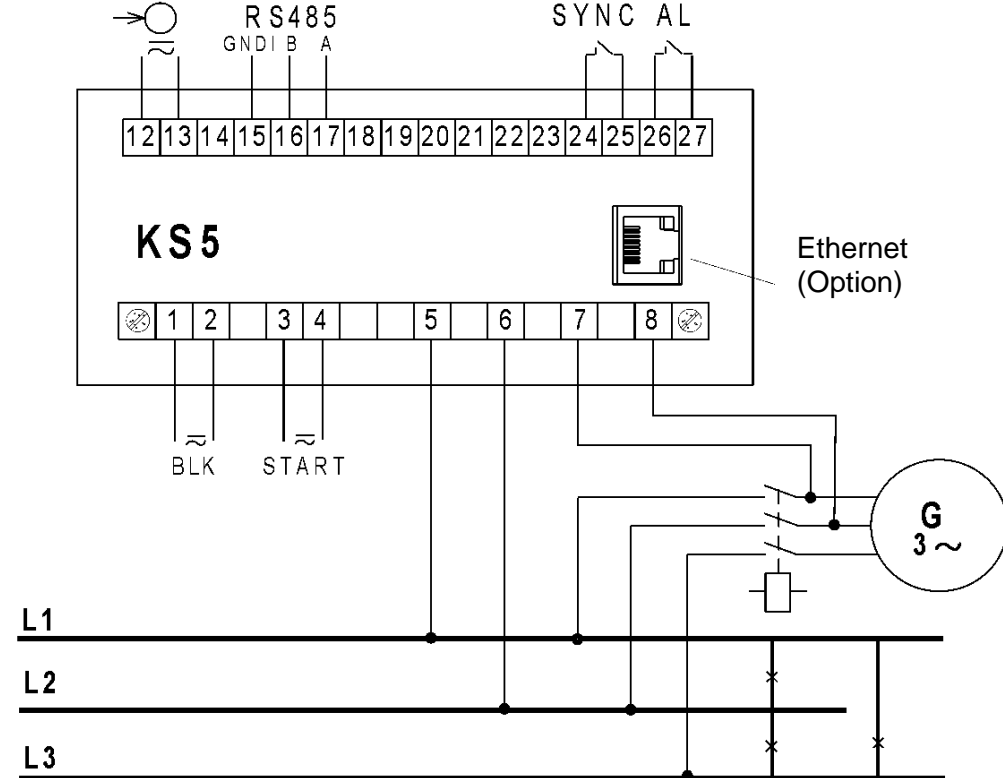


Fig. 4b Connections of the synchronizing unit - phase-to-phase measurement voltages

6 KS5 PROGRAMMING

6.1 General description



Fig.5 Front panel

KS5 synchronizing unit has 6 buttons and a graphical color display.
Description of the front panel:

| | | | |
|---|-------------------------------------|---|--------------------------|
| V, Hz, °,% | units of displayed quantities | K | kilo = 10 ³ , |
| U _S , f _S , U _G , f _G δf, δU, φ | Indications of displayed parameters | | |

Input measuring signals:

U_S - network voltage, f_S – network frequency,
U_G - generator voltage, f_G – generator frequency,

Input control signals:

BLK - synchronization lock (SYNC relay will not be activated even if the other synchronization conditions are met)

START - start of synchronization - unlocking the SYNC relay. After the START signal, the meter expects that measured values of the voltage δU and frequency δf difference and the phase shift φ of the voltage signals from the generator and the network will be within the set admissible values, then it generates a pulse that activates the SYNC relay with the set lead in time.

Output signals (relay contacts):

- AL - fault relay is activated in case of faulty external circuit connection when a fault occurs and if the measured values are outside the measuring range,
- SYNC - synchronization relay,

Calculated values:

δf , δU - difference in frequency and difference of voltage values of the generator and network signals,

ϕ - phase shift of the generator and network voltage signals,

The SYNC synchronization relay will be energized after synchronization conditions have been met.

Synchronization conditions:

$$-\delta U \leq \delta U \leq +\delta U$$

$$-\delta f \leq \delta f \leq +\delta f$$

$$|\phi| \leq \Delta\phi$$

BLK = "0"; START = "1" (detailed description in p. 7.3 Relays)

where:

$-\delta U$ - lower limit of voltage difference during synchronization,

$+\delta U$ - upper limit of voltage difference during synchronization,

$-\delta f$ - acceptable frequency difference when connecting "from below",

$+\delta f$ - acceptable frequency difference when connecting "from above",

ϕ - phase shift,

$\Delta\phi$ - acceptable phase shift,

The difference in the values of the voltage and frequency of the generator U_G, f_G and network U_S, f_S is calculated according to the formulas:

$$\delta U = 100 (U_G - U_S) / U_S [\%]$$

$$\delta f = 100 (f_G - f_S) / f_S [\%]$$

The phase shift of the generator voltage U_G relative to the network voltage U_S is expressed in degrees:

$$\phi = \angle (U_G, U_S) [^\circ]$$

Fixed phase shift compensation: positive value means that the generator voltage U_G is ahead of the network voltage U_S .

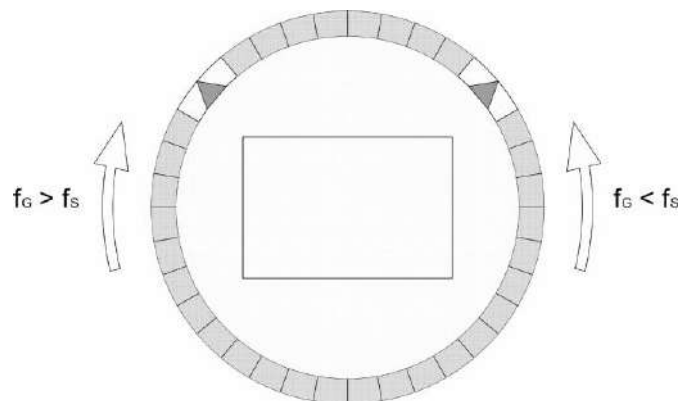


Fig.6, Synchronoscope with phase shift visualization

The spin speed and direction correspond to the difference between the network and the generator frequency.

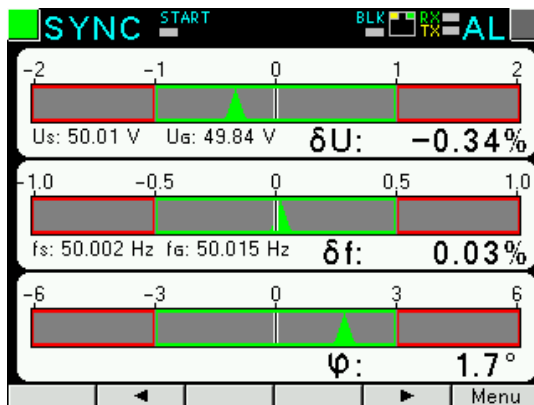


Fig.7. Screen when synchronization conditions are met

The values of measured parameters are presented on the next pages selected by pressing the following buttons: (next page) or (previous page). Meter buttons can perform various functions depending on the operating location. Functions are described on the bar at the bottom of the screen. If no description is present, it means that the button is inactive at that moment.

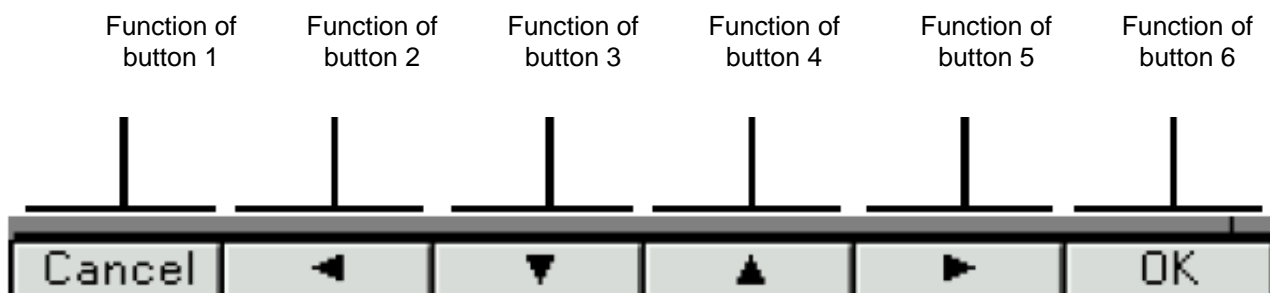


Fig.8, Sample designation of buttons

The top of the screen shows the status of the relay outputs (SYNC, AL), the status of control input signals START, BLK, the Ethernet connection symbol , indicators of receipt and transmit of the data at RS485 (RX, TX)

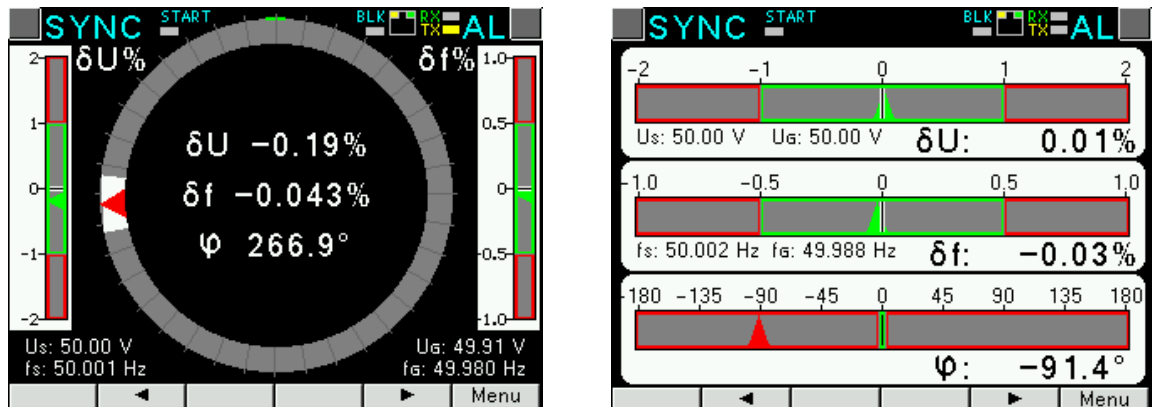


Fig.9, Visualization of measurements (synchronoscope, bar graphs)*

*The phase shift range on the synchronoscope screen: $0..360^{\circ}$,
the phase shift range on the bar graphs screen: $-180..+180^{\circ}$

6.2 Starting operation

When power is turned on, the synchronizing unit displays the logo, KS5 meter name, version, current firmware version and MAC for versions with Ethernet, and then switches to measurement mode. Displayed information:

KS5 v:1.00– type of the synchronizing unit, program version number

Bootloader v.01.05 bootloader version number

U: 50...150 V – voltage version

MAC: AA:BB:CC:DD:EE:FF (versions with Ethernet)

7 CONFIGURATION OF THE METER PARAMETERS

During normal operation (**Measurement**) the unit displays and signals the values that characterize the state and the course of the generator synchronization process. The KS5 meter performs voltage measurement functions (voltage difference), frequency (frequency difference), and phase shift between the voltage signals of the network and the generator.

The meter menu is divided into the following groups:

Parameters – configuration of parameters of the meter,

Relays – configuration of SYNC and AL relays,

Ethernet – configuration of Ethernet interface parameters,

Modbus – configuration of RS485 interface parameters,

Settings - settings: password, language, brightness level,

Information – preview of program version, serial no., MAC address,

To enter the parameter menu, press the button **Menu** for about 3 seconds.

Use the buttons   to select the desired group and accept with the button **Select**

Return to normal operation by pressing the button



| | | | | |
|-------------------|--------------------------------|----------------------------------|-----------------------------------|--|
| Parameters | Primary voltage of transformer | Secondary voltage of transformer | Compensation of fixed phase shift | Default settings of parameters |
| | 0000 <u>1</u> 00 | 00 <u>1</u> 00.0 | ±000, <u>0</u> | <input checked="" type="radio"/> No <input type="radio"/> Yes |

Fig. 10a. Programming matrix

| | | | | | | | |
|---------------|-------------|---|---|---|--|---|---|
| Relays | SYNC | Low value of voltage difference -δU [%] 000. <u>0</u> | High value of voltage difference δU [%] 000. <u>0</u> | Acceptable freq. difference at down -δ[f] 000.0 <u>0</u> | Acceptable freq. difference at up δ[f] 000.0 <u>0</u> | Down switching acceptable ZL- <input checked="" type="radio"/> Yes <input type="radio"/> No | Up switching acceptable ZL+ <input checked="" type="radio"/> Yes <input type="radio"/> No |
| | | Acceptable phase shift Δφ [°] 000. <u>0</u> | Relay lead time t _b SYNC [ms] 00 <u>0</u> | Pulse mode <input checked="" type="radio"/> permanent switching <input type="radio"/> switching pulse | Width of the switching pulse [ms] 00 <u>0</u> | Input signals BLK, START <input checked="" type="radio"/> Active <input type="radio"/> Inactive | Set defaults <input checked="" type="radio"/> No <input type="radio"/> Yes |
| | AL | Relative voltage difference δU [%] ≥ 000. <u>0</u> | Relative frequency difference δf [%] ≥ 000. <u>0</u> | Phase shift Δφ [°] ≥ 000. <u>0</u> | Set defaults <input checked="" type="radio"/> No <input type="radio"/> Yes | | |

Fig. 10b. Programming matrix

| | | | | | | | | |
|-----------------|-----------------------|---|--|--------------------------------------|--|--|--------------------------------|----------------------------------|
| Ethernet | Addresses | DHCP <input type="radio"/> Deact. <input checked="" type="radio"/> Act. | Mode <input type="radio"/> Auto <input checked="" type="radio"/> 10Mb/s <input type="radio"/> 100Mb/s | IP Address 00.000.000.00 <u>0</u> | Subnet Mask 255.255.255.00 <u>0</u> | Gateway Address 000.000.000.00 <u>0</u> | DNS Address 008.008.008.008 | MAC Address aa.bb.cc.00:21:01 |
| | | Acquired from DHCP or entered manually when DHCP is deactivated. | | | | | | |
| | Modbus TCP | Address 00 <u>1</u> | Port 0050 <u>2</u> | Max. connection limit 1 | Waiting time [s] 00 <u>1</u> | | | |
| WWW | Port 0008 <u>0</u> | | | | | | | |



Fig. 10c. Programming matrix


| | | | | | | |
|--------------------|----------|---|---|--|---------------|-------------------|
| Modbus | Address | Baudrate | Mode | | | |
| | 001 | <input type="radio"/> 4800b/s <input checked="" type="radio"/> 9600 b/s <input type="radio"/> 19,2 kb/s <input type="radio"/> 38,4 kb/s <input type="radio"/> 57,6 kb/s <input type="radio"/> 115,2 kb/s | <input checked="" type="radio"/> RTU 8N2 <input type="radio"/> RTU 8E1 <input type="radio"/> RTU 8O1 <input type="radio"/> RTU 8N1 | | | |
| Settings | Password | Language | Back light level | Set defaults meter params | | |
| | **** | <input type="radio"/> English <input checked="" type="radio"/> Polski <input type="radio"/> Deutsch | <input type="radio"/> Minimum <input type="radio"/> Medium <input checked="" type="radio"/> Maximum | <input checked="" type="radio"/> No <input type="radio"/> Yes | | |
| Information | Type | Order code | Boot Version | Program Version | Serial Number | MAC Address |
| | KS5 | 12200 | 1.04 | 1.00 | 15070006 | aa.bb.cc.00:21:01 |

Fig. 10d. Programming matrix

7.1 Measurement

Measurement – normal meter operation. Values of quantities characterizing the state and the course of the synchronization process of the generator are displayed and signaled. The KS5 meter performs voltage measurement functions (voltage difference), frequency (frequency difference), and phase shift between the voltage signals of the network and the generator.

You can change the page by pressing the button  or .

Maximum and minimum values are displayed on a separate page. Deleting maximum or minimum values is done by pressing the button .

7.2 Parameters




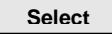
In this group the parameters of the meter are set. To enter the Parameters group press the button  for about 3 seconds and then using the button  or  select Parameters and confirm with the button .



Fig. 11. Screens for entering a password

Access to configuration of parameters is protected by a password, if it has been introduced and is different from zero. When the password is 0000, the password prompt is bypassed. If the password is incorrect, the message "Invalid password. Read-only menu." is displayed. Then you can view the parameters, but the changes are blocked.

When the password is valid or not entered, we can set values according to Table 1.

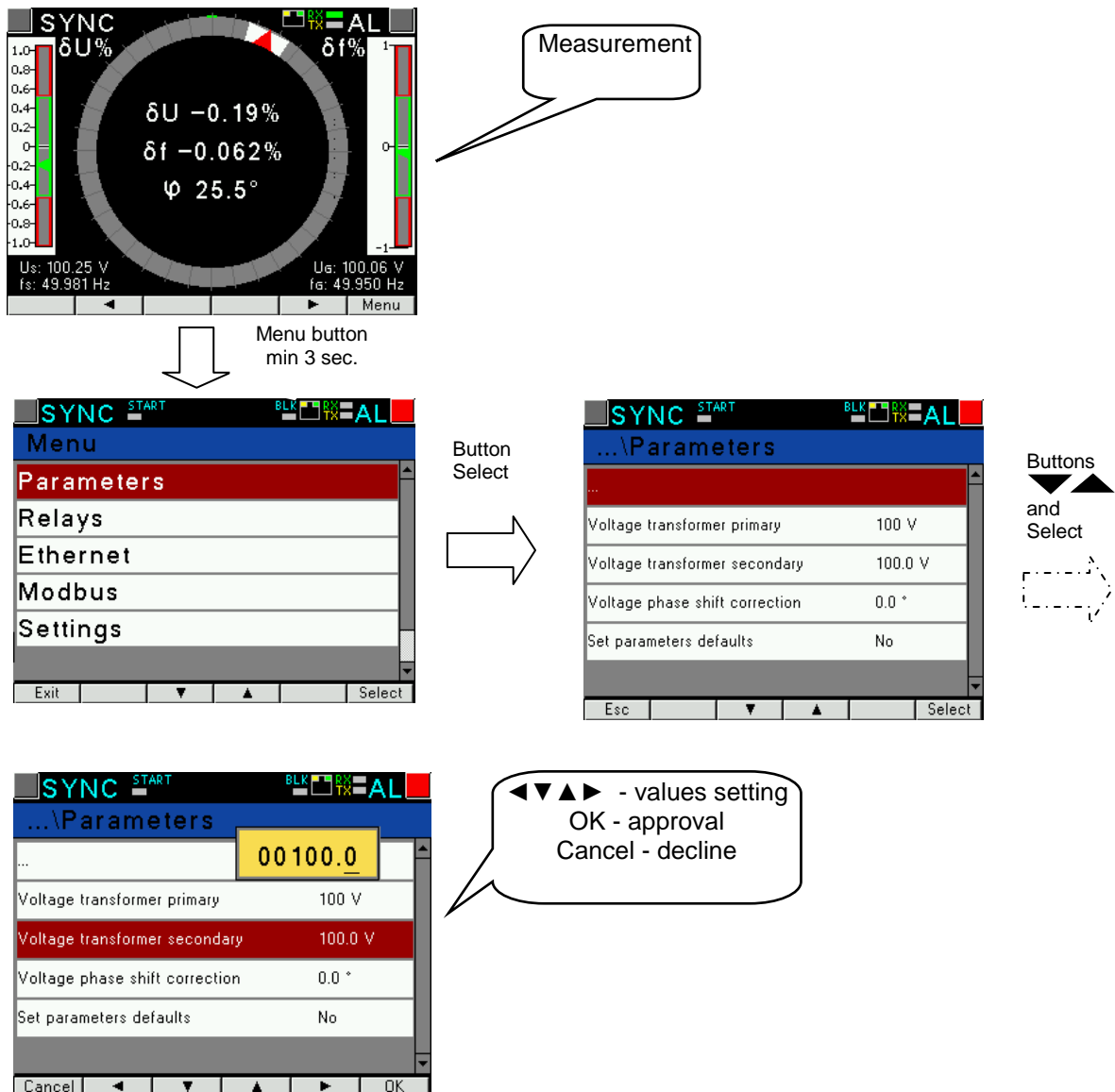


Fig.12, Screens of Parameter group



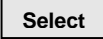








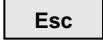

Using the buttons   we select a parameter and confirm it using the button . Then using the buttons   you can select the parameter characteristics or set the desired parameter values, i.e. the decimal digit position can be selected with the button  or , the value of the digit with the button  or . The active position is indicated by the cursor. The selected characteristic or value of the parameter should be confirmed by pressing the button  or canceled by pressing the button . To exit the Parameter procedure press the button  or wait for about 120 seconds. To exit the Menu of the parameter selection press the button  or wait for about 120 seconds.


Table 1

| No. | Parameter name | Characteristic / value | Description | Default value |
|-----|-----------------------------------|------------------------|-------------|---------------|
| 1 | Primary voltage of transformer | 1 .. 1245183 V | | 100 |
| 2 | Secondary voltage of transformer | 0.1 .. 1000.0 | | 100.0 |
| 3 | Compensation of fixed phase shift | -90.0° .. +90.0° | | 0.0° |
| 4 | Default settings of parameters | No, Yes | | No |

When a parameter changes, it is checked whether the value is within the range. In case of setting the value out of range, the value is set to the maximum value (when the value is too high) or to the minimum value (when the value is too low).

To configure KS5 synchronizing unit you can also use the free eCon software available at manufacturer's website.

7.3 Relays

Select **Relays** in the options and confirm by pressing the button .

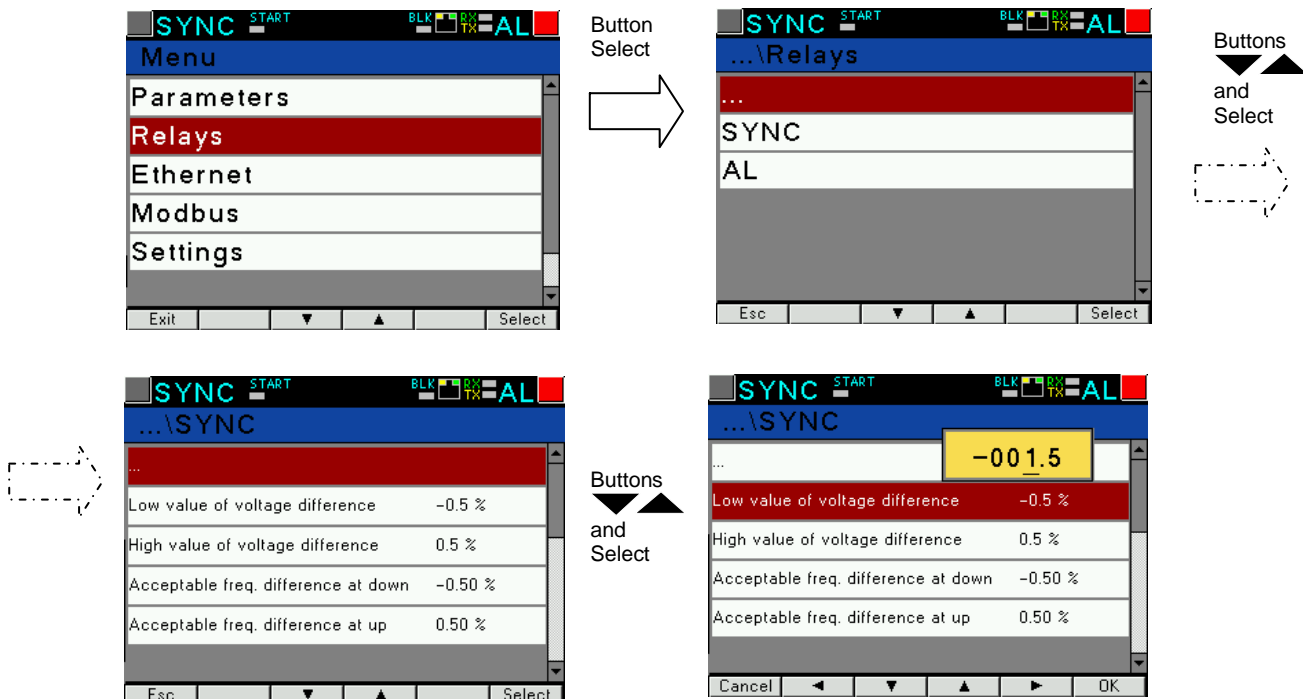
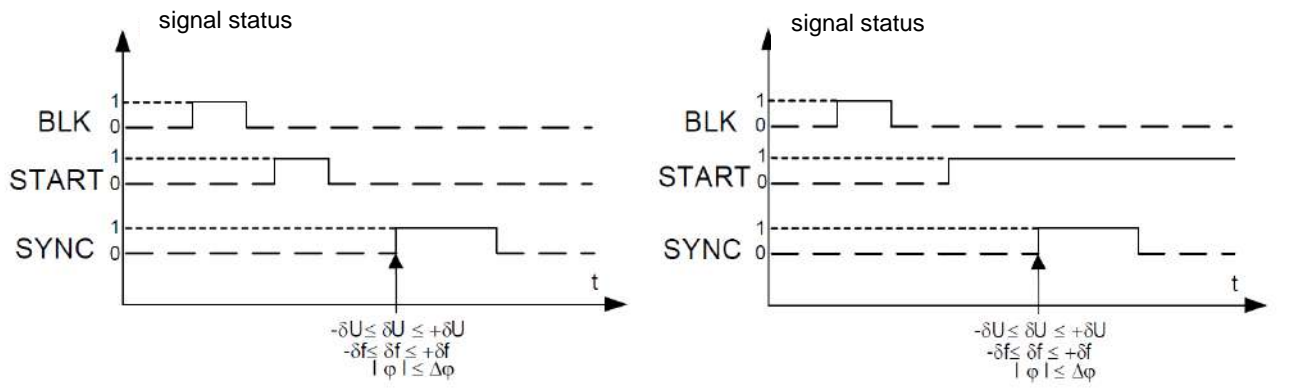


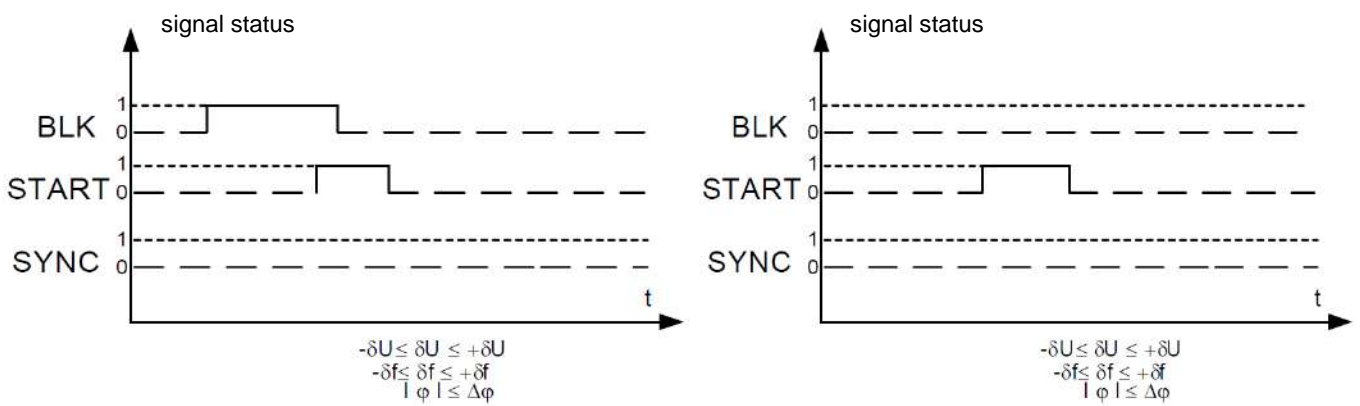
Fig.13.Screens of Relays group

Table 2

| No. | | Parameter name | range | Notes / description | Default value |
|-----|------------|--|--------------------|---|---------------|
| 1 | SYNC relay | Low value of voltage difference $-\delta U$ | -20.0 .. 0 [%] | $\delta U = 100 (U_G - U_S) / U_S$ [%] | -0.5 |
| 2 | | High value of voltage difference δU | 0 .. 20.0 [%] | | 0.5 |
| 3 | | Acceptable freq. difference at down - δf | -3.00 .. -0.00 [%] | $\delta f = 100 (f_G - f_S) / f_S$ [%] | -0.05 |
| 4 | | Acceptable freq. difference at up δf | 0.00 .. 3.00 [%] | | 0.05 |
| 5 | | Down switching acceptable ZL- | Yes No | | Yes |
| 6 | | Up switching acceptable ZL+ | Yes No | | Yes |
| 7 | | Acceptable phase shift $\Delta\phi$ | 0.0..20.0 [°] | | 2 |
| 8 | | Relay lead/ delay time t_b SYNC [ms] | -999..999 [ms] | t_b SYNC For positive values, the function acts as a relay switching lead. For negative values, the function acts as a relay switching delay. | 0 |
| 9 | | Pulse mode | No Yes | permanent switching switching pulse | No |
| 10 | | Width of the switching pulse [ms] | 0..999 [ms] | | 0 |
| 11 | | Input signals BLK, START | Active Inactive | Graphic illustration of BLK and START input signals control with SYNC synchronization relay in Fig.14 | Active |
| 12 | | Set defaults | Yes No | | No |
| 13 | | | | | |
| 14 | AL relay | Relative voltage difference $\delta U \geq$ | 20..100.0 [%] | $\delta U = 100 (U_G - U_S) / U_S $ [%] | 20 |
| 15 | | Relative frequency difference $\delta f \geq$ | 10..100.0 [%] | $\delta f = 100 (f_G - f_S) / f_S $ [%] | 10 |
| 16 | | Phase shift $\Delta\phi \geq$ | 20.0 .. 360.0 [°] | | 20 |
| 17 | | Set defaults | No yes | | No |



a,b) **SYNC** relay energized after synchronization conditions are met



c) **SYNC** relay not energized despite meeting synchronization conditions (START signal blocked by BLK signal)

d) **SYNC** relay not energized despite meeting synchronization conditions (BLK signal did not change its status from "1" to "0")

Fig.14, Graphic illustration of BLK and START input signals control with SYNC synchronization relay

7.4 Ethernet

Select **Ethernet** group in the options and confirm selection using the button .

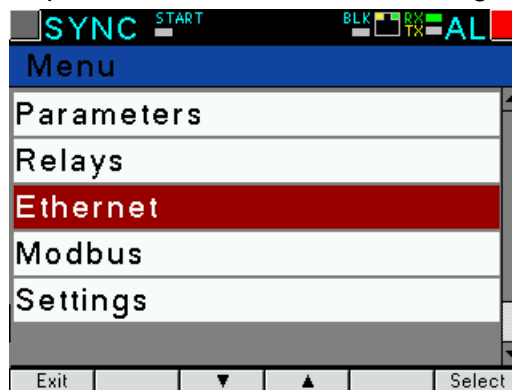


Fig.15, Ethernet mode screen

Table 3

| No. | | Parameter name | range | Notes / description | Default value | |
|-----|------------|-----------------------|---------------------------|---|--|---|
| 1 | Addresses | DHCP | Deact./Act. | Enabling/disabling DHCP client (the service of automatic acquiring the parameters of Ethernet interface IP protocol of the meter from external DHCP servers located within the same LAN network). | Deact. | |
| 2 | | Mode | Auto, 10Mb/s, 100Mb/s | | Auto | |
| 3 | | IP Address | 0.0.0.0...255.255.255.255 | 10.0.1.161 | Acquired from DHCP or entered manually when DHCP is deactivated. | - |
| 4 | | Subnet Mask | 0.0.0.0...255.255.255.255 | 255.0.0.1 | | - |
| 5 | | Gateway Address | 0.0.0.0...255.255.255.255 | 0.0.0.0 | | - |
| 6 | | DNS Address | 0.0.0.0...255.255.255.255 | 10.0.0.44 | | - |
| 7 | | MAC Address | | Aa:bb:cc:00:21:01 | - | |
| 8 | Modbus TCP | Address | 1 ... 247 | | 1 | |
| 9 | | Port | 80 ... 32000 | | 1 | |
| 10 | | Max. connection limit | 1 ... 4 | | 1 | |
| 11 | | Waiting time | 10 .. 360 | | 60s | |
| 12 | WWW | Port | 80 ... 32000 | | 80 | |

7.5 Modbus

Select **Modbus** group in the options and confirm by pressing the button .

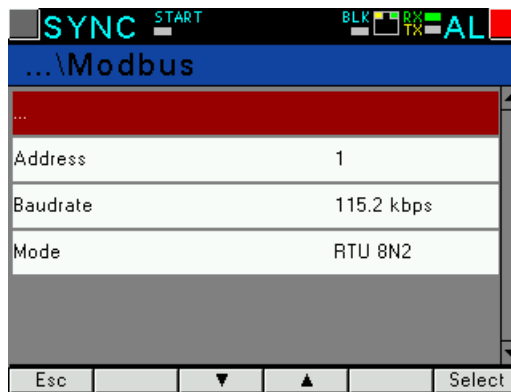


Fig.16. Screens of Modbus group

Table 4

| No. | Parameter name | Characteristic / value | Description | Default value |
|-----|----------------|---|--------------------------------|---------------|
| 1 | Address | 1...247 | Address on the Modbus network. | 1 |
| 2 | Baudrate | 4800 b/s, 9600 b/s, 19,2 kb/s, 38,4 kb/s, 57,6 kb/s, 115,2 kb/s | Baud rate | 9600 b/s |
| 3 | Mode | RTU 8N2, RTU 8E1, RTU 8O1, RTU 8N1 | Transmission mode | RTU 8N2 |

7.6 Settings

Select **Settings** group in the options and confirm by pressing the button .

Table 5

| No. | Parameter name | Characteristic / value | Description | Default value |
|-----|----------------------------|--------------------------|-------------|---------------|
| 1 | Password | 0 ... 9999 | 0 – off | 0 |
| 2 | Language | English, Polish, Deutsch | | Polish |
| 3 | Backlight level | Minimum, Medium, Maximum | | Maximum |
| 4 | Set defaults meter params. | No, Yes | | No |

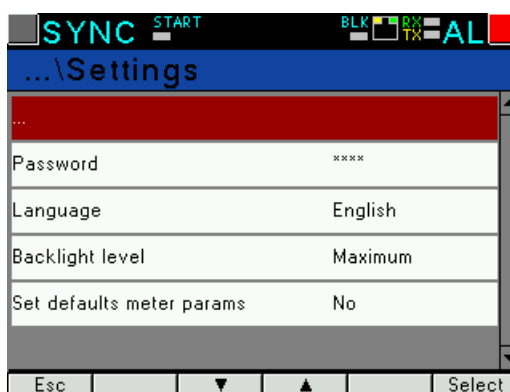


Fig.17, Screens of Settings group

7.7 Information

Select **Information** group in the options and confirm by pressing the button .

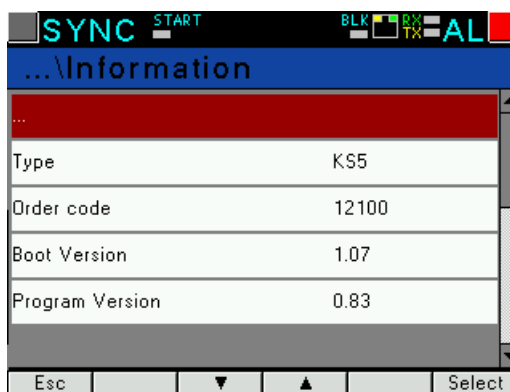


Fig.18. Screen of Information group

Table 6

| No. | Parameter name | Characteristic / value | Description | Default value |
|-----|-----------------|------------------------|-----------------------------------|---------------|
| 1 | Type | | Type of synchronizing unit | KS5 |
| 2 | Order code | | First 5 digits of ordering code | e.g.12200 |
| 3 | Boot Version | | Loader version | e.g.1.04 |
| 4 | Program Version | | Version of the meter main program | e.g.0.60 |

| | | | | |
|---|---------------|-------------------|--|---------------------------|
| 5 | Serial Number | ddmmxxxx | Current serial number of the meter day month current number | np.16070006 |
| 6 | MAC Address | xx:xx:xx:xx:xx:xx | 48-bit hardware address of the Ethernet interface written in hexadecimal | e.g.64:0E:0D:0C: 0B:0A |

8 SERIAL INTERFACES

8.1 RS485 INTERFACE – the list of parameters

The implemented protocol is in accordance with the standard PI-MBUS-300 Rev G of Modicon Company. The list of serial link parameters of KS5 meter:

- ID 0xDF
- meter address 1..247,
- baud rate 4.8, 9.6, 19.2, 38.4, 57.6, 115.2 kb/s,
- operation mode Modbus RTU,
- information unit 8N2, 8E1, 8O1, 8N1,
- maximum time to commence the response 600 ms,
- maximum number of read registers in one query
 - 61 registers – 4 byte,
 - 122 registers – 2 byte,
- implemented functions
 - 03, 04, 06, 16, 17,
 - 03, 04 registers reading,
 - 06 one register record
 - 16 n - registers record,
 - 17 device identification

Default settings: address 1, baud rate 9.6 kbit/s, RTU 8N2 mode,

8.2 Examples of registers reading and saving

Readout of n-registers (code 03h)

Example 1 . Readout of 2 16-bit registers of integer type, starting with the register addressed 0FA0h (4000) - registers values 10, 100.

Request:

| Address of the device | Function | Address of the register | | Number of registers | | Checksum CRC |
|-----------------------|----------|-------------------------|----|---------------------|----|--------------|
| | | B1 | B0 | B1 | B0 | |
| 01 | 03 | 0F | A0 | 00 | 02 | C7 3D |

Response:

| Address of the device | Function | Number of bytes | Value from the register 0FA0 (4000) | | Value from register 0FA1 (4001) | | Checksum CRC |
|-----------------------|----------|-----------------|-------------------------------------|----|---------------------------------|----|--------------|
| | | | B1 | B0 | B1 | B0 | |
| 01 | 03 | 04 | 00 | 0A | 00 | 64 | E4 6F |

Example 2 . Readout of 2 32-bit registers of float type as a combination of 2 16-bit registers starting with the register addressed 1B58h (7000) - registers values 10, 100.

Request:

| Address of the device | Function | Address of the register | | Number of registers | | Checksum CRC |
|-----------------------|----------|-------------------------|----|---------------------|----|--------------|
| | | B1 | B0 | B1 | B0 | |
| 01 | 03 | 1B | 58 | 00 | 04 | C3 3E |

Response:

| Address of the device | Function | Number of bytes | Value from the register 1B58 (7000) | | Value from the register 1B59 (7001) | | Value from the register 1B5A (7002) | | Value from the register 1B5B (7003) | | Checksum CRC |
|-----------------------|----------|-----------------|-------------------------------------|----|-------------------------------------|----|-------------------------------------|----|-------------------------------------|----|--------------|
| | | | B3 | B2 | B1 | B0 | B3 | B2 | B1 | B0 | |
| 01 | 03 | 08 | 41 | 20 | 00 | 00 | 42 | C8 | 00 | 00 | E4 6F |

Example 3 . Readout of 2 32-bit registers of float type as a combination of 2 16-bit registers starting with the register addressed 1770h (6000) - registers values 10, 100.

Request:

| Address of the device | Function | Address of the register | | Number of registers | | Checksum CRC |
|-----------------------|----------|-------------------------|----|---------------------|----|--------------|
| | | B1 | B0 | B1 | B0 | |
| 01 | 03 | 17 | 70 | 00 | 04 | 4066 |

Response:

| Address of the device | Function | Number of bytes | Value from the register 1770h(6000) | | Value from the register 1770h(6000) | | Value from the register 1772h(6002) | | Value from the register 1772h(6002) | | Checksum CRC |
|-----------------------|----------|-----------------|-------------------------------------|----|-------------------------------------|----|-------------------------------------|----|-------------------------------------|----|--------------|
| | | | B1 | B0 | B3 | B2 | B1 | B0 | B3 | B2 | |
| 01 | 03 | 08 | 00 | 00 | 41 | 20 | 00 | 00 | 42 | C8 | E4 6F |

Example 4 . Readout of 2 32-bit registers of integer type, starting with the register addressed 1D4Ch (7500)

- registers values 10, 100.

Request:

| Address of the device | Function | Address of the register | | Number of registers | | Checksum CRC |
|-----------------------|----------|-------------------------|----|---------------------|----|--------------|
| | | B1 | B0 | B1 | B0 | |
| 01 | 03 | 1D | 4C | 00 | 02 | 03 B0 |

Response:

| Address of the device | Function | Number of bytes | Value from the register 1D4C (7500) | | | | Value from register 1D4D (7501) | | | | Check sum CRC |
|-----------------------|----------|-----------------|-------------------------------------|----|----|----|---------------------------------|----|----|----|---------------|
| | | | B3 | B2 | B1 | B0 | B3 | B2 | B1 | B0 | |
| 01 | 03 | 08 | 41 | 20 | 00 | 00 | 42 | C8 | 00 | 00 | E4 6F |

Readout of single register (code 06h)

Example 5 . Record of 543 (0x021F) value to register 4000 (0x0FA0)

Request:

| Address of the device | Function | Address of the register | | Value of register | | Checksum CRC |
|-----------------------|----------|-------------------------|----|-------------------|----|--------------|
| | | B1 | B0 | B1 | B0 | |
| 01 | 06 | 0F | A0 | 02 | 1F | CA 54 |

Response:

| Address of the device | Function | Address of the register | | Value of register | | Checksum CRC |
|-----------------------|----------|-------------------------|----|-------------------|----|--------------|
| | | B1 | B0 | B1 | B0 | |
| 01 | 06 | 0F | A0 | 02 | 1F | CA 54 |

Recording to n-registers (code 10h)

Example 6. Readout of 2 registers, starting with the register addressed 0FA3h (4003)

Recording values 20, 2000.

Request:

| Address of the device | Function | Address of reg. Hi | Address of reg. Lo | No. of reg. Hi | No. of reg. Lo | Number of bytes | Value for reg. 0FA3 (4003) | | Value for reg. 0FA4 (4004) | | Checksum CRC |
|-----------------------|----------|--------------------|--------------------|----------------|----------------|-----------------|----------------------------|----|----------------------------|----|--------------|
| | | | | | | | B1 | B0 | B1 | B0 | |
| 01 | 10 | 0F | A3 | 00 | 02 | 04 | 00 | 14 | 07 | D0 | BB 9A |

Response:

| Address of the device | Function | Address of the register | | Number of registers | | Checksum CRC |
|-----------------------|----------|-------------------------|----|---------------------|----|--------------|
| | | B1 | B0 | B1 | B0 | |
| 01 | 10 | 0F | A3 | 00 | 02 | B2 FE |

Report identifying the device (code 11h)

Example 7. Device identification

Request:

| Address of the device | Function | Checksum |
|-----------------------|----------|----------|
| 01 | 11 | C0 2C |

Response:

| Address | Function | Number of bytes | ID | Device state | Information field for device software version (e.g. "KS5-1.00 b-1.06" - KS5 device with software version 1.00 and bootloader version 1.06) | Checksum (CRC) |
|---------|----------|-----------------|----|--------------|--|----------------|
| 01 | 11 | 19 | CF | FF | 4E 34 33 20 2D 31 2E 30 30 20 20 20 20 20 20 20 20 62 2D 31 2E 30 36 20 | E0 24 |

8.3 Ethernet 10/100-BASE-T

KS5 synchronizing units in the KS5-XX2XXXX version are equipped with Ethernet interface that allows for connection of the synchronizing unit (using RJ45 socket) to a local or global network (LAN or WAN). Ethernet interface allows to use network services implemented in the meter: web server, Modbus TCP/IP. To use the network services of the meter, you need to configure the parameters from the meter Ethernet group. Standard Ethernet parameters of the meter are shown in table 3. The basic parameter is the IP address of the meter - e.g. by default 10.0.1.161, which must be unique within the network to which we connect the device. The IP address can be assigned to the meter automatically by DHCP server present on the network provided that the the option to acquire IP address from DHCP server is enabled in the meter. Ethernet → Addresses → DHCP → Enabled. If DHCP service is disabled then the meter will work with the default IP address allowing the user to change the IP address, e.g. from the meter menu. The Ethernet parameters of the meter can also be changed via the

serial interface. Then the approval of changes is required by entering value “1” to the register 4149. After the changes are applied, the Ethernet interface is re-initialized according to the new parameters - all Ethernet interface services will be restarted.

8.3.1 Connection of 10/100 BASE-T interface

To access the Ethernet services, it is required to connect the meter to the network via the RJ45 slot located at the rear / inside the panel part of the meter, operating in accordance with TCP/IP protocol.

Description of RJ45 socket diodes function:

- yellow LED - illuminates when the meter is properly connected to the Ethernet network 100 Base-T, does not light up when the meter is not connected to the network or is connected to 10-Base-T network.
- green LED - Tx/Rx illuminates when the meter sends and receives data, it flickers irregularly, when no data is transmitted the diode lights up permanently

In order to connect the meter to the network the user should use twisted pair cable.

- U/FTP – twisted pair cable with each pair foiled,
- F/FTP – twisted pair cable with each pair foiled, additionally cable with foil shield,
- S/FTP (formerly SFTP) – twisted pair cable with each pair foiled, additionally cable with wire mesh shield,
- SF/FTP (formerly S-STP) – twisted pair cable with each pair foiled, additionally with foil and wire mesh shield,

Categories of twisted pair cable according to the European standard EN 50173 minimum: Class D (category 5) - for high-speed local area networks, includes applications using the frequency band up to 100 MHz. For Ethernet interface the user should use twisted pair cable of STP type (shielded) category 5 with RJ-45 connector with conductors colors (in accordance with the colors described in table 7) acc. to the following standard:

- EIA/TIA 568A for both connectors at the so-called simple connection of KS5 to the network hub or switch,
- EIA/TIA 568A for the first connector and EIA/TIA 568B for the second connector at the so-called patch cord connection (crossover) used, among others, when connecting KS5 to the computer.

Table 7

| Conductor no. | Signal | Conductor color acc. to standard | |
|---------------|--------|----------------------------------|--------------|
| | | EIA/TIA 568A | EIA/TIA 568B |
| 1 | TX+ | white-green | white-orange |
| 2 | TX- | green | orange |
| 3 | RX+ | white-orange | white-green |
| 4 | EPWR+ | blue | blue |
| 5 | EPWR- | white-blue | white-blue |

| | | | |
|---|-------|-------------|-------------|
| 6 | RX- | orange | green |
| 7 | EPWR- | white-brown | white-brown |
| 8 | EPWR- | brown | brown |

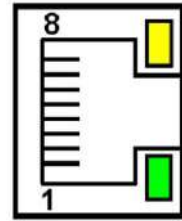


Fig.19. View and numbering of RJ45 slot pins

8.3.2 Web Server

KS5 synchronizing unit provides its own Web server that allows remote monitoring of measured values and readout of the meter status. With the web page the user can:

- obtain device information (serial number, execution code, firmware version, bootloader version, variant (standard or special),
- preview of the current measurement values, readout of the device status,
- select the language for the Website,

The access to the Web server is achieved by entering the meter IP address in the web browser, e.g.: <http://192.168.1.030> (where 192.168.1.030 is the set address of the meter). The standard port for web server is port "80". Server port may be changed by the user.

Caution: For proper website operation a browser with JavaScript enabled and compatible with XHTML 1.0 is required (all popular browsers, Internet Explorer, version 8 minimum).

8.3.2.1 General view

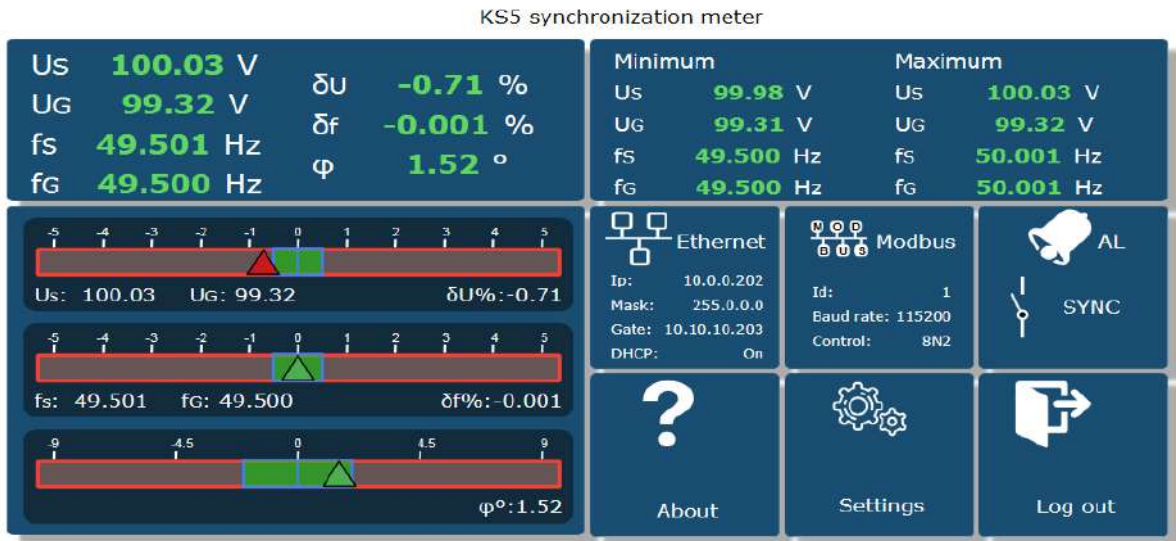


Fig. 20. View of the meter WWW page

8.3.2.2 Selection of Web Server user

The meter has two user accounts for the web server secured with an individual passwords:

- user: "admin", password: "admin" - access to configuration and the preview of parameters
- user: "user", password: "pass" - access to the preview of parameters only.

Calling the meter IP address in the browser, for example <http://192.168.1.30> will show the start display in the browser where the user must enter the name and password.

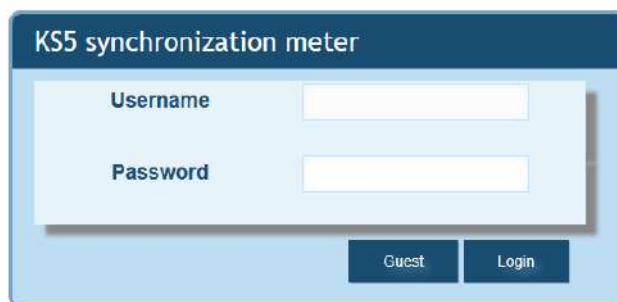


Fig. 21. View of the synchronizing unit web server log window

Web server user names cannot be changed. However, it is possible to change the password for each user - it is recommended to change passwords for security reasons. Password change is only possible through the web page in "Ethernet" parameters group. Passwords can have a maximum of 8 characters. If the password is lost - which will prevent you from using

the web server, you must restore the Ethernet interface parameters e.g. from the menu: Settings → Factory settings → Yes, or by entering a value of "1" in register 4152. All standard parameters of the meter including the Ethernet parameters (according to Table 9) and user passwords for WWW server will be restored:

user "admin" → password: "admin" ;

user "user" → password "pass".

8.3.3 Modbus TCP/IP

KS5 synchronizing unit allows access to internal registers via Ethernet and Modbus TCP/IP. In order to set up a connection it is necessary to set a unique IP address for the meter and to set the connection parameters listed in Table 8.

Table 8

| Register | Description | Default value |
|----------|---|---------------|
| 4146 | Device address for Modbus TCP/IP | 1 |
| 4147 | Port number of Modbus TCP | 502 |
| 4145 | Time to close the port of Modbus TCP/IP service [s] | 60 |
| 4144 | The maximum number of simultaneous connections to Modbus TCP/IP service | 4 |

The device address is the device address for Modbus TCP/IP protocol and is not the same as the address value for Modbus RS485 protocol (Modbus Address 4100). By setting the "Device Address for Modbus TCP/IP Protocol" parameter to "255", the meter will skip the address analysis in the Modbus protocol frame (broadcast mode).

9 MAP OF REGISTERS OF KS5 METER

In KS5 meter the data are placed in 16- and 32-bit registers. Process variables and parameters of the meter are located in the address space of registers in a manner dependent on the type of the variable. Bits in 16-bit register are numbered from the youngest to the oldest (b0-b15). 32-bit registers contain floating point numbers in IEEE-754 standard. Byte order 3210 – the oldest is sent first.

Table 9

| Address range | Value type | Description |
|---------------|-------------------|---|
| 4000 – 4053 | Integer (16 bits) | Value placed in one 16-bit register. Registers for the meter configuration. Description of registers can be found in table 10. Registers for recording and reading. |
| 4400- 4420 | Integer (16 bits) | Value placed in one 16-bit register. Registers of statuses, energy values, the meter MAC address, configuration data. Description of registers can be found in table 11. Read-only registers. |
| 6000 – 6050 | Float (2x16 bits) | Values placed in two successive 16-bit registers. Registers contain the same data as 32-bit registers of 7500 – 7530 range. Read-only registers. Byres order (1-0-3-2) |
| 7500 – 7525 | Float (32 bits) | Values placed in a single 32-bit register. Description of registers can be found in table 12. Read-only registers. |
| 8000 - 8050 | Float (2x16 bits) | Values placed in two successive 16-bit registers. Registers contain the same data as 32-bit registers of 7500 – 7525 range. Read-only registers. Byres order (3-2-1-0) |

Table 10

| Address of the register | Operations | Range | Description | Default |
|-------------------------|------------|--------------------|--|-----------------------------|
| 4000 | RW | 0...9999 | Protection - password | 0 |
| 4001 | RW | | Reserved | |
| 4002 | RW | | Reserved | 0 |
| 4003 | RW | 0..18 | Primary voltage of transformer, two older bytes | 0 |
| 4004 | RW | 0..65535 | Primary voltage of transformer, two younger bytes | 100 |
| 4005 | RW | 0..65535 | Secondary voltage of transformer x 10 500...1500 V (version 1) 1500...4000 V (version 2) | 1000 or 2300 |
| 4006 | RW | -200 .. 0 [‰] | SYNC relay - lower limit value of voltage difference | -5 |
| 4007 | RW | 0 .. 200 [‰] | SYNC relay - upper limit value of voltage difference | 5 |
| 4008 | RW | -300 .. 0 [%/100] | Acceptable frequency difference when connecting "from below", | -5 |
| 4009 | RW | 0 .. 300 [%/100] | Acceptable frequency difference when connecting "from above", | 5 |
| 4010 | RW | -900 .. 900 [°/10] | Correction of combined voltages phase shift x 10 | 0.0 |
| 4011 | RW | 0.1 | Permit to connect the generator "from below" 0 - No 1 - Yes | 1 |
| 4012 | RW | 0.1 | Permit to connect the generator "from above" 0 - No 1 - Yes | 1 |
| 4013 | RW | 0 .. 200 [°/10] | Acceptable phase shift x 10 | 20 |
| 4014 | RW | -999 .. 999 [ms] | Lead/delay time of SYNC relay switching | 0 |
| 4015 | RW | 0.1 | Switching pulse 0 - permanent switching 1 - switching pulse | 0 |
| 4016 | RW | 100 .. 999 [ms] | Length of switching pulse | 150 |
| 4017 | RW | 0.1 | External lock 0 - No 1 - Yes | 1 |
| 4018 | RW | 0.1 | Deleting minimum and maximum values | 0 |
| 4019 | RW | | Reserved | |
| 4020 | RW | 200 .. 1000 [‰] | AL relay - relative voltage difference \geq | 200 |
| 4021 | RW | 100 .. 1000 [‰] | AL relay - relative frequency difference \geq | 100 |
| 4022 | RW | 200 .. 3600 [°/10] | AL relay - phase shift x10 \geq | 200 |
| 4023 | RW | | Reserved | |
| 4024 | RW | | Reserved | |
| 4025 | RW | 1..247 | Address on the Modbus network. | 1 |
| 4026 | RW | 0..3 | Transmission mode: 0->8n2, 1->8e1, 2->8o1, 3->8n1 | 0 |
| 4027 | RW | 0..5 | Transmission speed: 0->4800, 1->9600 2->19200, 3->38400, 4->57600, 5->115200 | 1 |
| 4028 | RW | | Reserved | |
| 4029 | RW | 0.1 | Update the change of transmission parameters | 0 |
| 4030 | RW | | Reserved | |
| 4031 | RW | | Reserved | |
| 4032 | RW | 0...65535 | Third and second byte (B3.B2) of meter IP address, format IPv4: B3.B2.B1.B0 | 49320 (0xC0A8 = 192.168) |
| 4033 | RW | 0...65535 | First and zero byte (B1.B0) of meter IP address, | 356 (0x0164) |

| | | | | |
|------|----|------------|---|------------|
| | | | format IPv4: B3.B2.B1.B0 | = 1.100) |
| 4034 | RW | 0...65535 | Third and second byte (B3.B2) of meter subnet mask address, mask format: B3.B2.B1.B0 | 65535 |
| 4035 | RW | 0...65535 | First and zero byte (B1.B0) of meter subnet mask address, mask format: B3.B2.B1.B0 | 65280 |
| 4036 | RW | 0...65535 | Third and second byte (B3.B2) of meter default gateway, gateway address format: B3.B2.B1.B0 | 49320 |
| 4037 | RW | 0...65535 | First and zero byte (B1.B0) of meter default gateway address, format: B3.B2.B1.B0 | 257 |
| 4038 | RW | 0...65535 | Third and second byte (B3.B2) of meter DNS address, format IPv4: B3.B2.B1.B0 | 0x0808=8.8 |
| 4039 | RW | 0...65535 | First and zero byte (B1.B0) of meter DNS address, format IPv4: B3.B2.B1.B0 | 0x0808=8.8 |
| 4040 | RW | | Reserved | |
| 4041 | RW | 0.1 | Enabling/Disabling DHCP Client (service of automatic acquiring of the meter Ethernet IP parameters from External DHCP Servers within the same Local Area Network) 0 - DHCP service disabled – manually configure the IP address and subnet mask of the meter; 1- DHCP service enabled, after powering up, or after selecting the menu option APPL, or after entering value “1” to register 4099 the meter will automatically receive the IP address, subnet mask and gateway address from the DHCP server, the gateway address will be the address of the server which assigned the meter parameters, | 1 |
| 4042 | RW | 0 .. 2 | Ethernet interface baud rate: 0 – automatic selection of baud rate 1 – 10 Mb/s 2 – 100 Mb/s | 0 |
| 4043 | RW | | Reserved | |
| 4044 | RW | | Reserved | |
| 4045 | RW | 1...4 | The maximum number of simultaneous connections to Modbus TCP/IP service | 1 |
| 4046 | RW | 10...360 | Time to close the port of Modbus TCP/IP service, in seconds | 60 |
| 4047 | RW | 1...247 | Device address for Modbus TCP/IP | 1 |
| 4048 | RW | 80...32000 | Port number of Modbus TCP | 502 |
| 4049 | RW | 80...32000 | Web server port number | 80 |
| 4050 | RW | 0.1 | Storing new parameters of Ethernet interface and re-initiating the interface 0 – no changes, 1 – memorizing new parameters and re-initiating Ethernet interface, | 0 |
| 4051 | RW | 0..2 | Menu language: 0-ENG, 1-PL, 2-DE | 1 |
| 4052 | RW | 1...3 | Level of brightness: 1 – Minimum, 2- Medium 3 - Maximum | 3 |
| 4053 | RW | 0.1 | Recording standard parameters (with resetting min, max) including Ethernet, | 0 |

Table 11

| Address of the register | Operations | Range | Description | Default |
|-------------------------|------------|-----------|--|-----------------|
| 4400 | R | | Reserved | |
| 4401 | R | 0..65535 | Identifier | DF |
| 4402 | R | 0..65535 | Bootloader version x 100 | - |
| 4403 | R | 0..65535 | Program version x100 | - |
| 4404 | R | | Reserved | |
| 4405 | R | 0..65535 | Ordering code | - |
| 4406 | R | 0..65535 | Nominal voltage x10 | 1000 or 2300 |
| 4407 | R | | Reserved | |
| 4408 | R | | Reserved | |
| 4409 | R | | Reserved | |
| 4410 | R | | Reserved | |
| 4411 | R | | Reserved | |
| 4412 | R | | Reserved | |
| 4413 | R | 0..65535 | Third and second byte (B3.B2) of serial number, format B7:B6:B5:B4:B3:B2:B1:B0 | |
| 4414 | R | 0..65535 | First and zero byte (B1.B0) of serial number, format B7:B6:B5:B4:B3:B2:B1:B0 | - |
| 4415 | R | 0..65535 | Status register 1– description below | - |
| 4416 | R | 0..65535 | Status register 2– description below | - |
| 4417 | R | | Reserved | |
| 4418 | R | | Reserved | |
| 4419 | R | | Reserved | |
| 4420 | R | | Reserved | |
| 4421 | R | 0...65535 | Fifth and fourth byte (B5.B4) of meter MAC address, format B5:B4:B3:B2:B1:B0 | - |
| 4422 | R | 0...65535 | Third and second byte (B3.B2) of meter MAC address, format B5:B4:B3:B2:B1:B0 | - |
| 4423 | R | 0...65535 | First and zero byte (B1.B0) of meter MAC address, format B5:B4:B3:B2:B1:B0 | - |
| 4424 | R | | Reserved | |

Device status register 1 (address 4415, R):

| | |
|---------------------------------------|---|
| Bit 15 – “1” – FRAM memory corruption | Bit 7 – “1” – reserved |
| Bit 14 - "1" - no input calibration | Bit 6 – “1” – reserved |
| Bit 13 – “1” – reserved | Bit 5 – “1” – reserved |
| Bit 12 – “1” – reserved | Bit 4 – “1” – reserved |
| Bit 11 – “1” – reserved | Bit 3 – “1” – reserved |
| Bit 10 – “1” – reserved | Bit 2 - "1" - device version with Ethernet |
| Bit 9 – “1” – reserved | Bit 1 - "1" - Ethernet connection established |
| Bit 8 – “1” – reserved | Bit 0 - "1" - Ethernet cable connected |

Device status register 2 (address 4416, R):

| | |
|---|---|
| Bit 15 – “1” – SYNC | Bit 7 – “1” – reserved |
| Bit 14 – “1” – AL | Bit 6 - "1" - phase shift error ϕ |
| Bit 13 – “1” – reserved | Bit 5 - "1" - frequency difference error δf |
| Bit 12 – “1” – reserved | Bit 4 - "1" - voltage difference error δU |
| Bit 11 - "1" - generator frequency too low | Bit 3 - "1" - generator frequency f_G outside the range |
| Bit 10 - "1" - generator frequency too high | Bit 2 - "1" - network frequency f_S outside the range |
| Bit 9 – “1” – START | Bit 1 - "1" - generator voltage U_G outside the range |
| Bit 8 – “1” – BLK | Bit 0 - "1" - network voltage U_S outside the range |

Table 12

| Address of 16-bit registers 2x16 1032/ 2x16 3210 | Address of the register 32 bits | Operations | Description | Unit |
|--|------------------------------------|------------|--|------|
| 6000/8000 | 7500 | R | Network voltage U_S | V |
| 6002/8002 | 7501 | R | Generator voltage U_G | V |
| 6004/8004 | 7502 | R | Network frequency f_S | Hz |
| 6006/8006 | 7503 | R | Generator frequency f_G | Hz |
| 6008/8008 | 7504 | R | Value of voltage difference δU | % |
| 6010/8010 | 7505 | R | Value of frequency difference δf | % |
| 6012/8012 | 7506 | R | Phase shift ϕ , range: 0..360 | ° |
| 6014/8014 | 7507 | R | Phase shift ϕ , range: -180..+180 | ° |
| 6016/8016 | 7508 | R | Reserved | |
| 6018/8018 | 7509 | R | Reserved | |
| 6020/8020 | 7510 | R | Reserved | |
| 6022/8022 | 7511 | R | Reserved | |
| 6024/8024 | 7512 | R | Reserved | |
| 6026/8026 | 7513 | R | Reserved | |
| 6028/8028 | 7514 | R | Reserved | |
| 6030/8030 | 7515 | R | Status register 1 | - |
| 6032/8032 | 7516 | R | Status register 2 | - |
| 6034/8034 | 7517 | R | Reserved | |
| 6036/8036 | 7518 | R | Reserved | |
| 6038/8038 | 7519 | R | Reserved | |
| 6040/8040 | 7520 | R | Voltage U_S min | V |
| 6042/8042 | 7521 | R | Voltage U_S max | V |
| 6044/8044 | 7522 | R | Voltage U_G min | V |
| 6046/8046 | 7523 | R | Voltage U_G max | V |
| 6048/8048 | 7524 | R | Frequency f_S min | Hz |
| 6050/8050 | 7525 | R | Frequency f_S max | Hz |
| 6052/8052 | 7526 | R | Frequency f_G min | Hz |
| 6054/8054 | 7527 | R | Frequency f_G max | Hz |
| 6056/8056 | 7528 | R | Value of voltage difference δU_{min} | V |
| 6058/8058 | 7529 | R | Value of voltage difference δU_{max} | V |
| 6060/8060 | 7530 | R | Value of frequency difference δf_{min} | % |
| 6062/8062 | 7531 | R | Value of frequency difference δf_{max} | % |
| 6064/8064 | 7532 | R | Reserved | |
| 6066/8066 | 7533 | R | Reserved | |

10 FIRMWARE UPGRADE

KS5 meters have a feature that allows the user to upgrade the software using a PC with eCon software. Free eCon software and update files are available at www.lumel.com.pl. Software update of the meter (firmware) can be performed via RS485 interface. The update is done in LUMEL UPDATER tab.

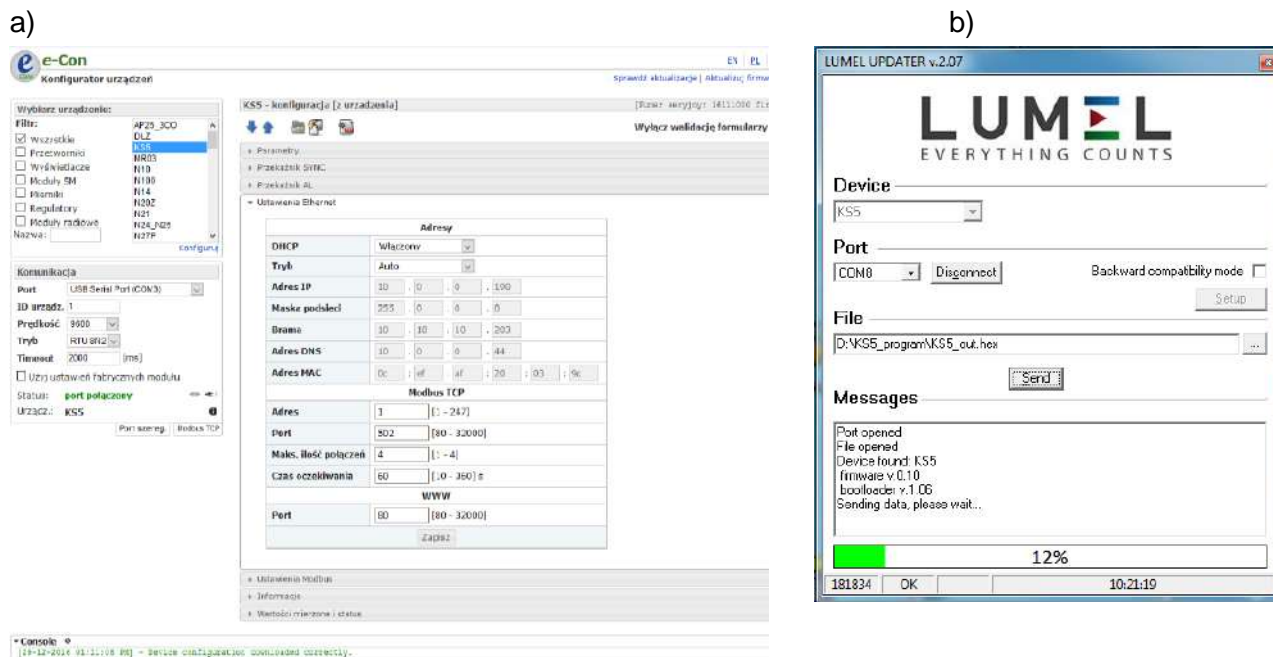



Fig.22. View of program window: a) eCon, b) firmware upgrade

Caution! After upgrading the software, the user should set the factory settings of the meter, therefore it is recommended to preserve the initial meter parameters before the upgrade with the use of eCon software.



After starting eCon the serial port, speed, mode and meter address should be set in the settings. Then select KS5 meter and click *Configure* To read all the settings, click the down arrow, then the floppy icon to save the settings to a file (to restore them later). After selecting *Update firmware* (in the upper right corner of the screen) *Lumel Updater* (LU) window will open - Fig. 22 b. Press *Connect*. *Messages* information window contains info about the progress of the upgrade process. When the port is properly opened the display shows: *Port opened*. There are two ways to enter the upgrade mode: remotely through the LU (based on settings in eCon - address, mode, speed, COM port) and by turning on the meter power by pushing the button  (when entering the bootloader mode with the button, communication parameters: speed 9600, RTU8N2, address 1). The display will show boot with bootloader version, and LU program will show the message *Device found* and the name and program version of the connected device. Press the "... " button and select the meter update file. When the file is properly opened the following message is displayed *File opened*. Press *Send* button. After successful upgrade the monitor switches to normal operation, and the information window shows *Done* and the upgrade duration. After closing the LU window, go to *Service Parameters*, select *Set Meter Defaults* and press the *Restore* button. Then press the folder icon to open the previously saved settings file and press the up arrow to save the settings in the meter. The current software version can also be checked by reading the greeting

messages of the meter after powering up.

Caution! Turning off the power during the software upgrade may result in permanent damage to the meter!

11 ERROR CODES

During operation of the meter, error messages may appear on the display. The causes of the errors are listed below.

- **Err bat** – displayed when the battery of the internal RTC clock is worn. Battery check is performed after powering. The message can be turned off with the button . Disabled message remains inactive until the sync meter is turned on again;
- **Err CAL, Err EE** – displayed when the memory in the sync meter has been damaged. The meter must be returned to the manufacturer.
- **Err PAR** – displayed when the operating parameters of the meter are incorrect. Restore the factory settings (from the menu or via RS485). The message can be turned off with the button .
- **ΛΛΛΛ** – upper overrun. The value is measured outside the measurement range.
- **VVVV** – lower overrun. The value is measured outside the measurement range.

12 TECHNICAL DATA

Measurement ranges and acceptable errors

Table 13

| Measured quantity | Measurement range | Resolution | Class / intrinsic error |
|---|---|---------------------------|-------------------------|
| Voltage U_n : 50 .. 150 V~ 150 .. 400 V~ | <u>20 .. 180 V</u> <u>60 .. 480 V</u> (*) ...1920 kV (tr_U≠1) | 0.1 V 0.1 V 0.01 kV | 0.2 (EN 61557-12) |
| Frequency f | 40.. <u>45</u> .. <u>65</u> ..100 Hz | 0.001 Hz | 0.02 (EN 61557-12) |
| Phase shift ϕ | <u>0..360</u> ^o <u>-180..+180</u> ^o | 0.1 ^o | $\pm 0.5^{\circ}$ |

* U_n - phase or phase-to-phase voltage (programmable in the selected range); maximum operating voltage relative to earth 300 V,

tr_U - Ratio of voltage transformer = Primary voltage of transformer / Secondary voltage of voltage transformer,

Power consumption:

- in power supply circuit ≤ 6 VA
 ≤ 0.5 VA
- in voltage circuit

Readout field

color graphic screen TFT 3.5" with resolution of 320 x 240 pixels

Relay outputs (AL, SYNC)

2 programmable relays, volt free NO contacts, resistive load
0.5 A/250 V a.c. or 5 A/30 V d.c.
Relay switching time 8 ms (max),
Number of switchings: mechanical minimum 5×10^6
electric minimum 1×10^5

| | |
|--------------------------------------|---|
| Control inputs (BLK, START) | 2 voltage inputs 20..250 V d.c./a.c. Power consumption per input ≤ 0.25 W |
| RS485 serial interface | Modbus RTU 8N2,8E1,8O1,8N1. Address 1..247, Baud rate 4.8, 9.6, 19.2, 38.4, 57.6, 115.2 kbit/s maximum time to commence the response: 600 ms |
| Ethernet Interface | 10/100 Base-T, RJ45 socket, Web Server, Modbus TCP/IP server, DHCP client |
| Sampling | A/C converter 16-bit Sampling rate 6.4 kHz for 50 Hz 7.68 kHz for 60 Hz Simultaneous sampling across all channels, 128 samples per period |
| Real-time clock | ± 20 ppm, battery of RTC CR2032 |

Terminals

| | |
|-------------------|-----------------------------|
| Cross-section | 0.05 .. 2.5 mm ² |
| Clamping screws | M3 |
| Tightening torque | 0.5 Nm |

Degree of protection provided by housing

| | |
|---------------------|-------|
| from the front side | IP 65 |
| from the panel side | IP 20 |

Weight 0.3 kg

Dimensions 96 x 96 x 77 mm

Reference and rated operating conditions

| | |
|-----------------------------|--|
| - power supply | 85..253 V a.c. (40.. <u>50</u> ..400) Hz or 90..300 V d.c. or 20..40 V a.c. (40.. <u>50</u> ..400) Hz or 20..60 V d.c. |
| - input signal: | <u>0,4..1,2</u> U _n frequency 40.. <u>50</u> .. <u>60</u> ..100 Hz; sinusoidal (THD $\leq 8\%$) |
| - phase shift | <u>0</u> .. <u>360</u> ^o or <u>-180</u> .. <u>+180</u> ^o for frequency f _n ± 5 Hz (f _n =50 or 60 Hz) |
| - ambient temperature | -10.. <u>23</u> ..+55 °C, K55 class acc. to EN61557-12 |
| - storage temperature | -20.. <u>+70</u> °C |
| - humidity | 0 .. <u>40</u> .. <u>60</u> ..95 % (no condensation) |
| - acceptable crest factor : | |
| - voltage | 2 |
| - external magnetic field | \leq <u>40</u> ...400 A/m d.c. ≤ 3 A/m a.c. 50/60 Hz |
| - short-term overload | |
| - voltage inputs 5 sec. | 2 Un |
| - operation position | any |
| - warm-up time | 15 min. |

Real-time clock battery: CR2032

Additional errors:

in % of intrinsic error

- due to ambient temperature changes < 50 % / 10 °C
- for THD > 8% < 50 %

Standards met by the synchronizing unit**Electromagnetic compatibility**

- immunity to interference in accordance with EN 61000-6-2
- noise emission acc. to EN 61000-6-4

Safety requirements:

according to PN-EN 61010-1 standard

- insulation between circuits: basic,
- installation category III for voltages up to 300V in relation to earth
- degree of pollution 2
- maximum operating voltage relative to earth
 - for power and relay outputs circuits 300 V
 - for measurement input 300 V
 - for RS485, Ethernet circuits: 50 V
- altitude < 2000m

13 ORDERING CODES

Ordering code for KS5 synchronizing unit

Table 14

| Meter | KS5 | X | X | X | XX | X | X |
|-------------------------------------|-----|---|---|---|----|---|---|
| Input voltage Un* | | | | | | | |
| 50...150 V | | 1 | | | | | |
| 150...400 V | | 2 | | | | | |
| Interfaces | | | | | | | |
| RS485 | | | 1 | | | | |
| RS485 and Ethernet | | | 2 | | | | |
| Power supply | | | | | | | |
| 85..253 V a.c., 90..300 V d.c. | | | | 1 | | | |
| 20..40 V a.c., 20..60 V d.c. | | | | 2 | | | |
| Versions | | | | | | | |
| standard | | | | | 00 | | |
| special** | | | | | XX | | |
| Language | | | | | | | |
| Polish | | | | | | P | |
| English | | | | | | E | |
| other** | | | | | | X | |
| Acceptance tests: | | | | | | | |
| without additional requirements | | | | | | | 0 |
| with quality inspection certificate | | | | | | | 1 |
| With calibration certificate | | | | | | | 2 |
| acc. to customer's requirements** | | | | | | | X |

* Un - phase or phase-to-phase voltage (programmable in the selected range); maximum operating voltage relative to earth 300 V,

**after agreement with the manufacturer

SAMPLE ORDER, code **KS5 12100E0** means:

KS5 –synchronizing unit,

1 – input voltage 50...150 V,

2 – RS485 and Ethernet,

1 – power supply voltage 85..253 V a.c., 90..300 V d.c.

00 – standard version,

E –English language version,

0 – without extra requirements.



LUMEL
EVERYTHING COUNTS

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